DIGESTION AND ABSORPTION OF PROTEINS

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Advance Clinical Biochemistry I (MA 407)

Summer Semester

Week Seven

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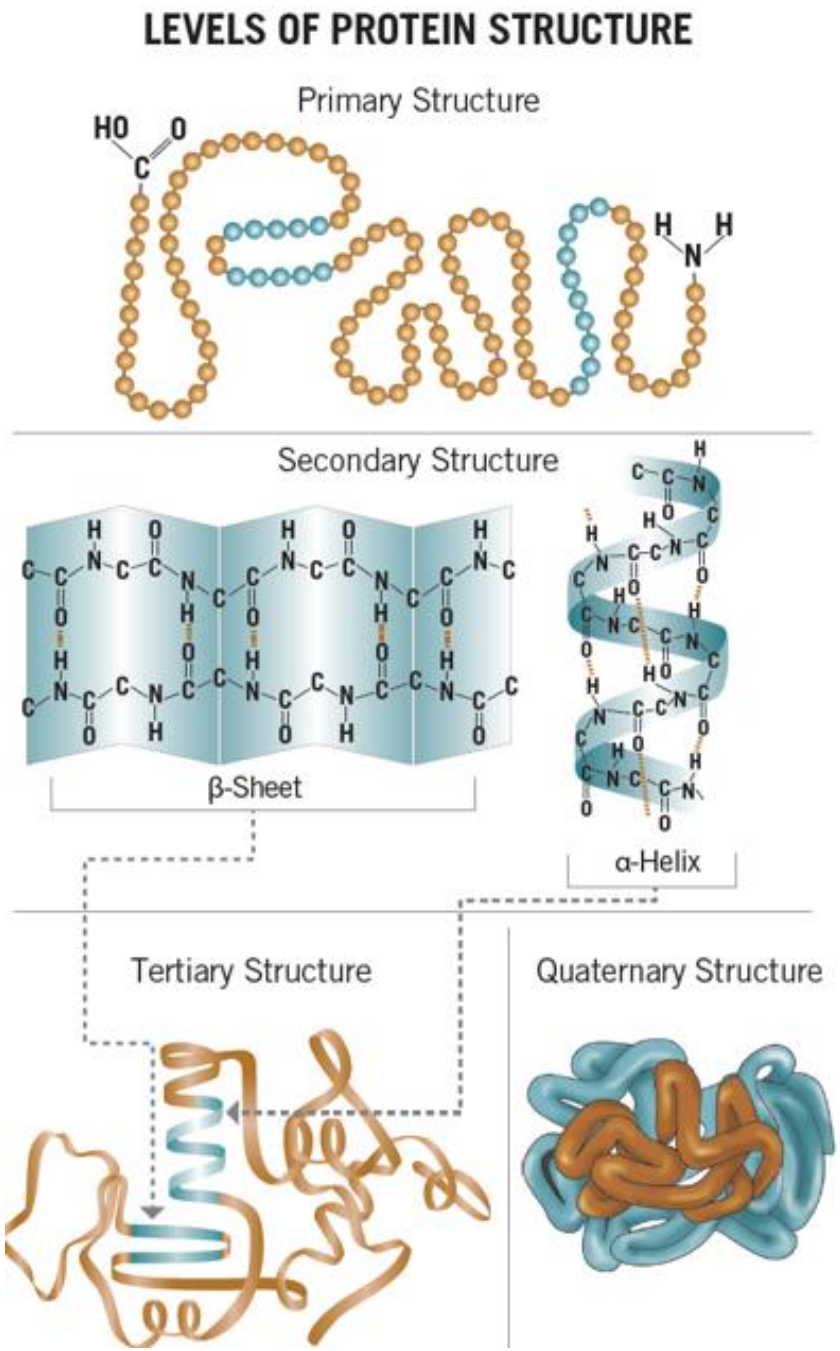
Outlines

- Objectives
- Introduction
- Dietary Protein Digestion
- Digestion in Stomach
- Digestion in SI
- Absorption into blood
- Summary
- Class activities

Objectives

- **At the end of the lesson, the students should be able to understand:**

- The importance of dietary protein
- The role of dietary proteins in the maintenance of quality life.
- Digestion of dietary proteins in the stomach, duodenum & SI
- The uptake of peptides and amino acids from the GIT
- The absorption and transport of amino acid to liver



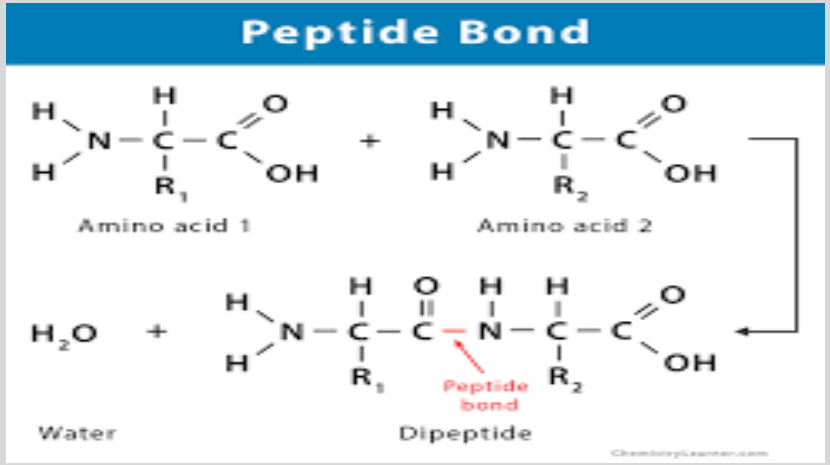
Introduction

- **A protein** is a large, complex molecule composed of one or more chains of amino acids linked by peptide bonds.
- **Functions:** Proteins perform a vast array of functions in living organisms, including building and repairing tissues, catalyzing biochemical reactions, transporting molecules, supporting immune responses, and regulating cellular processes.
- **Structural Classification**: Primary, Secondary, Tertiary and Quaternary
- **Component:** 20 standard amino acids
- **Special Bond:** Peptide bond

Cont.

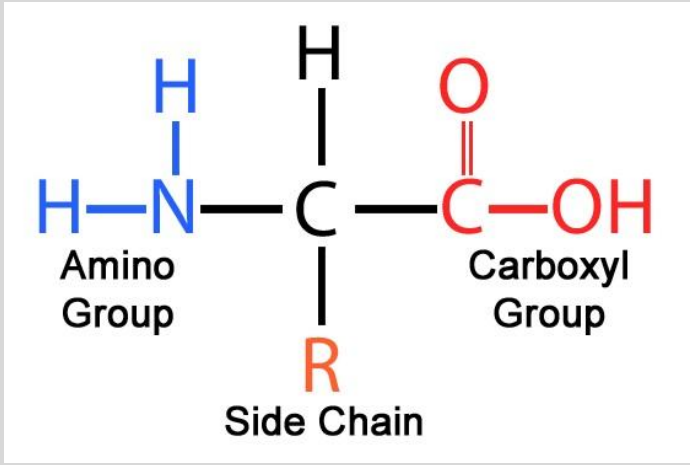
- Peptide?
- Molecules that are composed of two or more amino acids joined through:

- **Amide formation (peptide bond)** between
- **Carboxyl group** of the first amino acid and
- **Amino group of the next amino acid**.



- Amino acids?
- An amino acid is an organic molecule with:

- **Basic amino group ($-NH_2$),**
- **Acidic carboxyl group (–COOH),**
- **Organic R group (or side chain).**



Nutritionally Essential	Nutritionally Nonessential
Arginine[a]	Alanine
Histidine	Asparagine
Isoleucine	Aspartate
Leucine	Cysteine
Lysine	Glutamate
Methionine	Glutamine
Phenylalanine	Glycine
Threonine	Hydroxyproline[b]
Tryptophan	Hydroxylysine[b]
Valine	Proline
	Serine
	Tyrosine

Digestion of Dietary Protein

- The body's digestive system breaks down dietary protein into individual amino acids.
- The amino acids are absorbed and used by cells to build other proteins and a few other macromolecules, such as DNA.
- Being a good source of dietary protein, one egg (raw, hard-boiled, scrambled, or fried), supplies about six grams of protein.

Digestion in the Mouth

- Unless it is eating raw, the first step in digesting an egg as dietary protein (or any other protein in solid food) is chewing.
- The teeth begin the **mechanical breakdown** of large protein pieces into smaller ones that can be swallowed.
- The salivary glands secrete saliva to aid swallowing and the passage of the partially mashed proteins (egg) through the esophagus.

Digestion in the Stomach

- The mashed protein (egg) pieces enter the stomach from the esophagus.
- Both mechanical and chemical digestion takes place in the stomach.
- The stomach releases gastric juices containing HCl and enzymes (pepsin), which initiate the chemical digestion of protein.
- Muscular contractions, called peristalsis, also aid in digestion.
- The powerful stomach contractions churn the partially digested protein into a more uniform mixture called chyme.

Chemical Digestion of proteins

Mechanical Digestion

Acid (Hydrochloric)

Pepsin (Enzyme)

Gastric juices

Muscular contractions (Peristalsis)

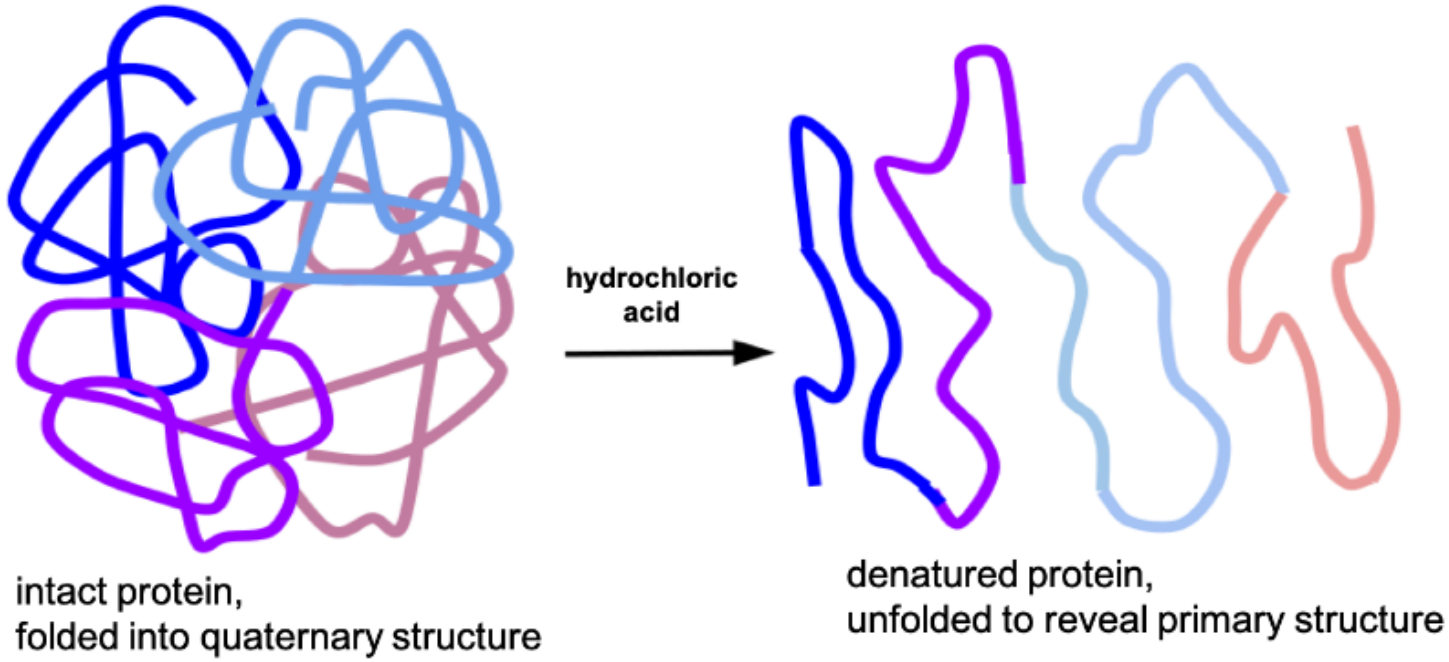
Digestion in the Stomach

- **The acidic nature of the stomach (**pH of 1.5-4.5) **causes food proteins to denature.**

- **Unfolding their three-dimensional structure** to reveal just the polypeptide chain (the first step of chemical digestion of proteins) destroys protein function.

- This is what makes insulin not to be taken orally, its function will be destroyed in the digestive tract, first by denaturation and then further by enzymatic digestion.

Digestion in the Stomach

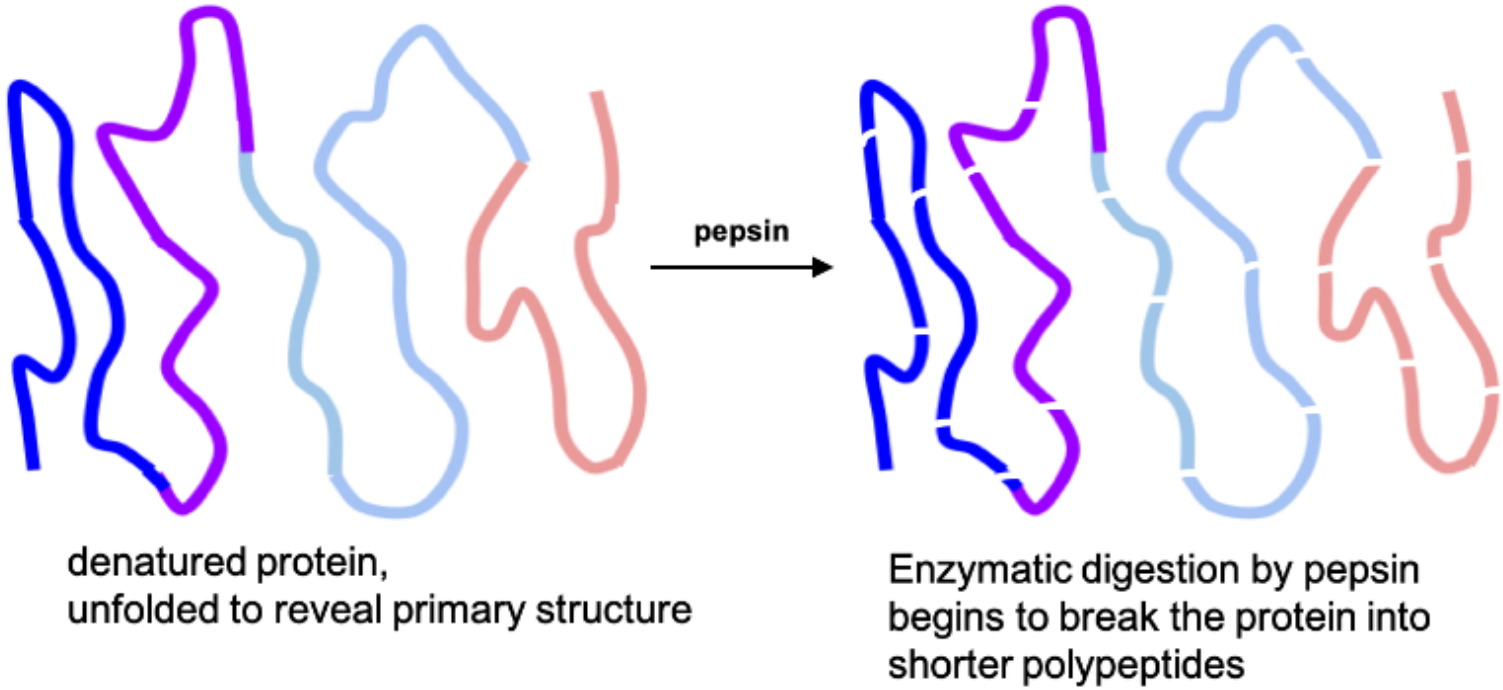


- In the stomach, proteins are denatured because of the acidity of hydrochloric acid.

Digestion in the Stomach

- Once proteins are denatured in the stomach, the peptide bonds linking amino acids together are more accessible for enzymatic digestion.
- That process is started by an enzyme called pepsin which is an activated form of pepsinogen.
- Pepsin begins breaking peptide bonds, creating shorter polypeptides.

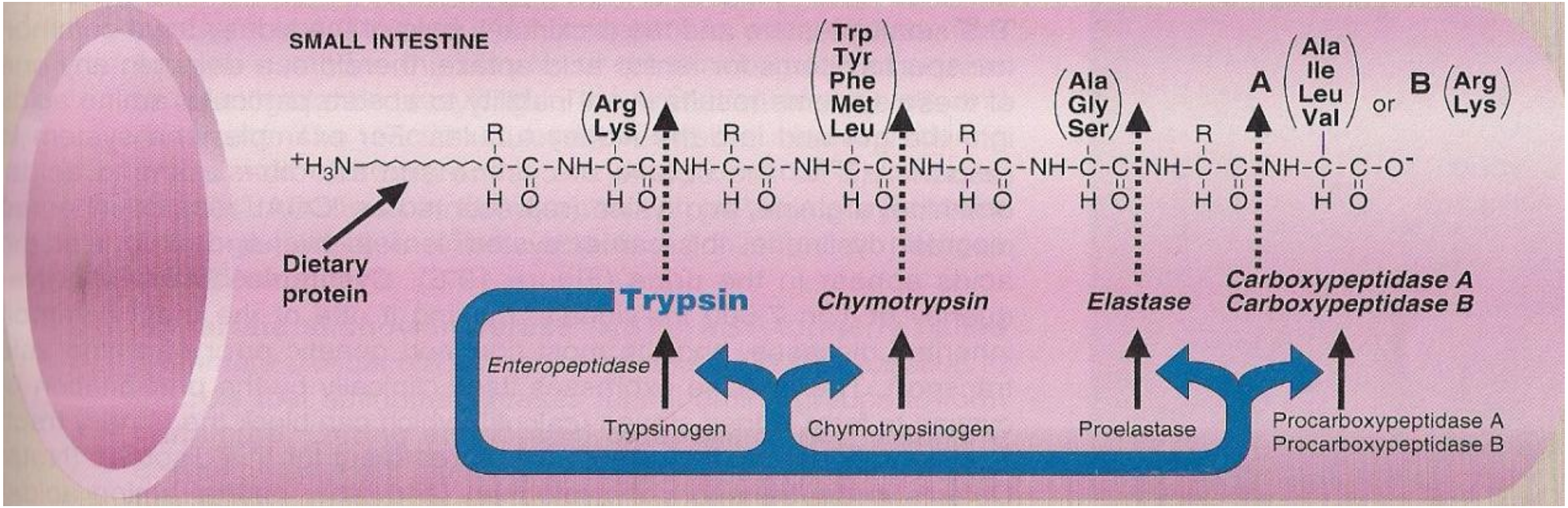
Digestion in the Stomach



- Enzymatic digestion of proteins begins in the stomach with the action of the enzyme pepsin.

Digestion at the Small Intestine

- The chyme leaves the stomach and enters the small intestine, where the majority of protein digestion occurs.
- The pancreas secretes digestive juices into the small intestine, and these contain more enzymes to further break down polypeptides.
- The two major pancreatic enzymes that digest proteins in the small intestine are **chymotrypsin** and **Trypsin**.
- Trypsin activates other protein-digesting enzymes called proteases and together, these enzymes **break down proteins into tripeptides, dipeptides, and individual amino acids.**

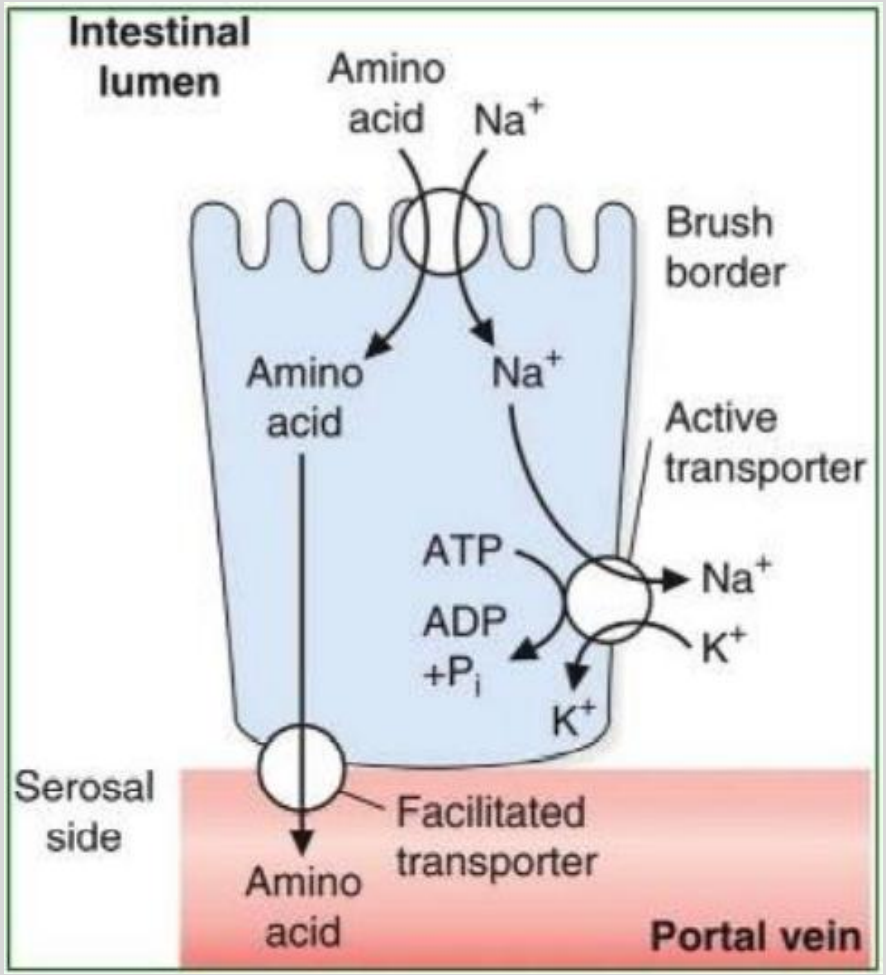


Digestion in the Lumen

Cont.

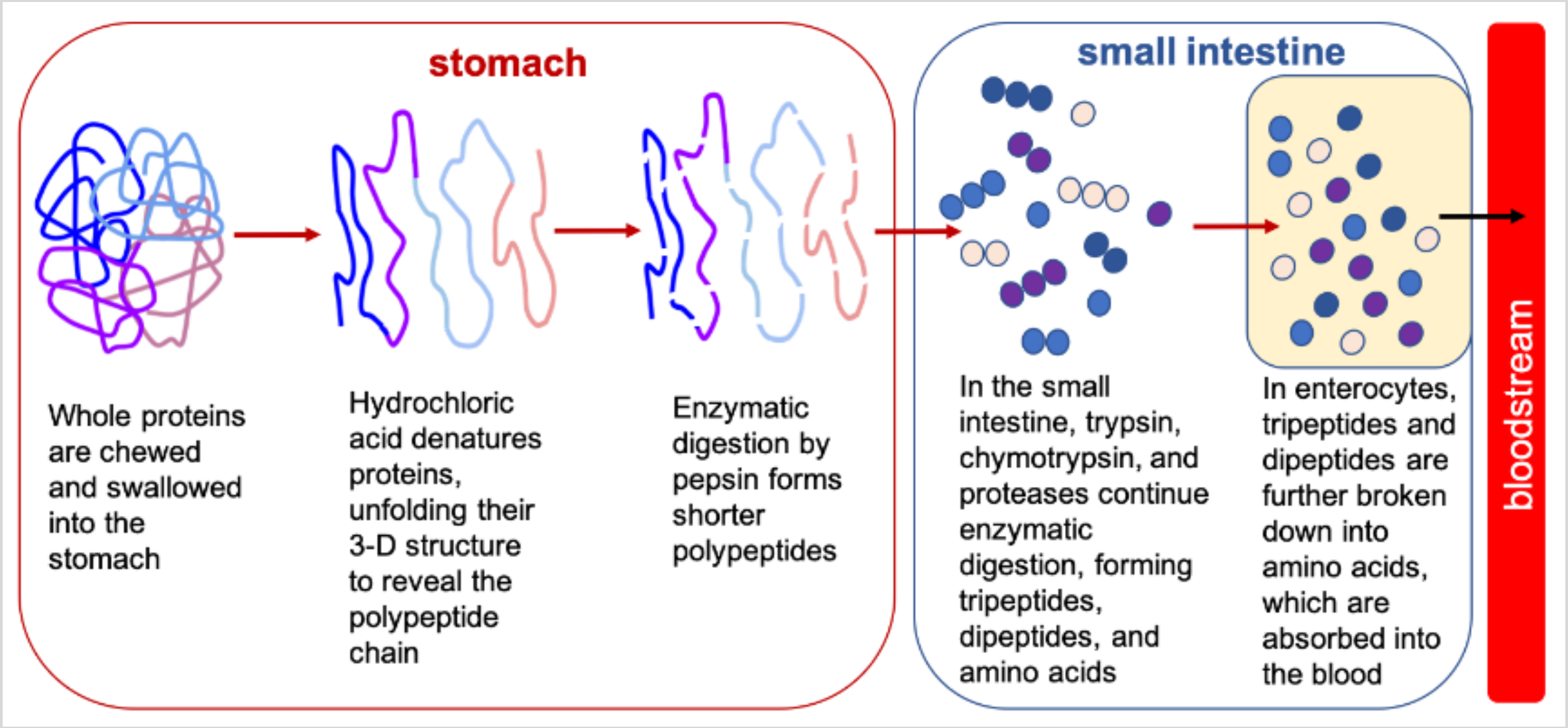
- The cells that line the small intestine release additional enzymes that also contribute to the enzymatic digestion of polypeptides.
- Tripeptides, dipeptides, and single amino acids enter the enterocytes of the small intestine using active transport systems, which require ATP.
- Once inside, the tripeptides and dipeptides are all broken down to single amino acids, which are absorbed into the bloodstream.
- There are several different types of transport systems to accommodate different types of amino acids.
- Amino acids with structural similarities end up competing to use these transporters.

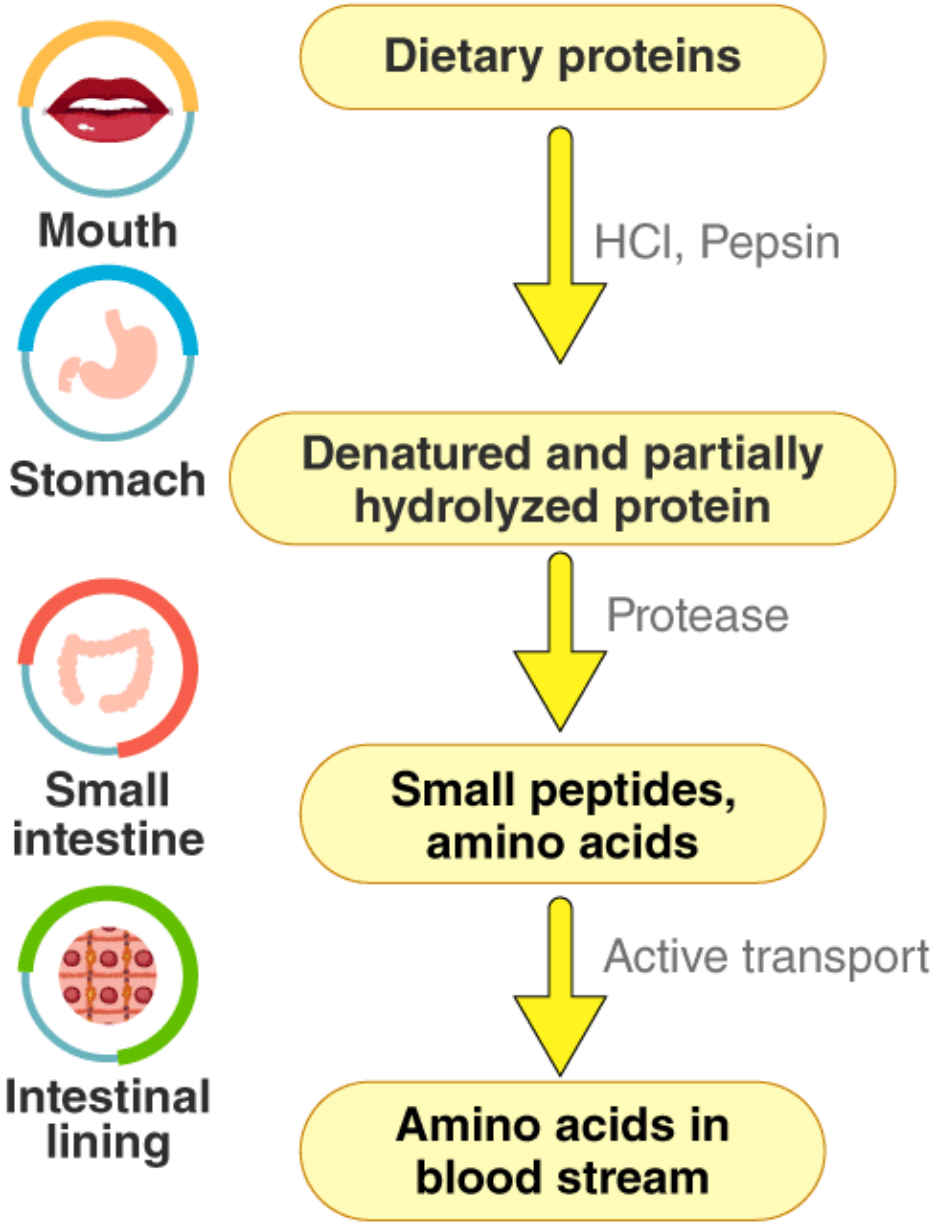
Cont.



- Proteins that aren't fully digested in the small intestine pass into the large intestine and are eventually excreted in the feces.
- Plant-based proteins are a bit less digestible than animal proteins due to their presence in the cell walls.

Summary


stomach
small intestine
Whole proteins are chewed and swallowed into the stomach
Hydrochloric acid denatures proteins, unfolding their 3-D structure to reveal the polypeptide chain
Enzymatic digestion by pepsin forms shorter polypeptides
In the small intestine, trypsin, chymotrypsin, and proteases continue enzymatic digestion, forming tripeptides, dipeptides, and amino acids
In enterocytes, tripeptides and dipeptides are further broken down into amino acids, which are absorbed into the blood
bloodstream


Dietary proteins
HCl, Pepsin
Mouth
Denatured and partially hydrolyzed protein
Stomach
Protease
Small peptides, amino acids
Small intestine
Active transport
Amino acids in blood stream
Intestinal lining
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SUMMARY

Class Activity

1. Protein digestion begins in the mouth with the action of salivary enzymes. **True/False**.
2. Hydrochloric acid in the stomach causes dietary proteins to denature **True/False**.
3. Pepsin is an enzyme that is secreted by the pancreas and breaks down peptide bonds in the small intestine. **True/False**.
4. Trypsin and chymotrypsin are two major pancreatic enzymes that digest proteins in the small intestine. **True/False**.
5. Amino acids are absorbed into the bloodstream directly from the small intestine. **True/False**.
6. Protein digestion begins in the _____ with the action of gastric enzymes.
7. The end products of protein digestion are _____, which are the building blocks of proteins.
8. The enzyme that activates other pancreatic enzymes involved in protein digestion is _____.
9. The process of moving amino acids from the intestinal lumen into the intestinal cells is called _____.
10. The transport protein that carries most of the amino acids in the blood is _____.

References

- Murray, K., Rodwell, V., Bender, D., Botham, K. M., Weil, P. A., & Kennelly, P. J. (2009). Harper's illustrated biochemistry. 28. *Citeseer, New York, United States*.

- Nelsen, D. L., & Cox, M. M. (2021). *Lehninger principles of biochemistry*. Macmillan Learning.

- Wee, M. S., & Henry, C. J. (2020). Reducing the glycemic impact of carbohydrates on foods and meals: Strategies for the food industry and consumers with special focus on Asia. *Comprehensive reviews in food science and food safety*, *19*(2), 670-702.


Questions
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